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VEGETATIVE REPRODUCTION IN AN EPHEDRA

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY 172

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(WITH FIVE FIGURES)

When the branches of many plants are covered with soil or even make contact with it, they may put out roots and produce new plants. This method of reproduction is common among angiosperms and to a less degree among gymnosperms, where heretofore it has been reported only for Coniferales. Many species, distributed among *Abies*, *Picea*, *Pinus*, *Larix*, *Pseudotsuga*, *Thuja*, *Chamaecyparis*, and *Cryptomeria*, produce new plants by the rooting of horizontal branches which then either erect the tip of the rooting branch or send out erect lateral shoots. The unfortunate term "layering" has been applied to this method of vegetative reproduction.

The latest account for a gymnosperm is that of COOPER[1], who describes "layering" in *Abies balsamea* and cites the scanty literature of the subject.

Until now no special method of vegetative reproduction has been reported for Gnetales, perhaps because the relative inaccessibility of the group has prevented careful field studies.

In September 1911 occasional clumps of an *Ephedra* were found on the very steep rocky sides of the cañon of Rifle Creek, near the southern boundary of the White River forest reserve in western Colorado. This *Ephedra* is probably conspecific with *E. nevadensis*, although differing from the latter in some minor characters.

Rifle Creek, where it falls over the edge of the White River plateau, for some miles has carved out of very hard limestone a box cañon with walls in some places rising perpendicularly to a height of more than 150 meters (fig. 1), or even leaning outward over the cañon floor. Emerging from the box cañon the stream flows for a short distance through soft limestone with regular slopes steeply V-shaped, then through sandstone conglomerate, which being very friable weathers rapidly. The faces of the sandstone slopes show a series of low cliffs (fig. 2) alternating with nearly bare talus. The walls of the cañon are exceedingly unstable.

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[1] COOPER, WILLIAM S., Reproduction by layering among conifers. BOT. GAZ. **52**:369–379. *fig. 1.* 1911.

Ephedra is sparsely distributed along the canon walls for nearly four miles, occurring only on the most exposed and most unstable slopes in clumps of from four or five plants to sometimes twenty or infrequently more. Isolated plants are rare and an examination of one of these showed that it had been torn from a clump on a cliff above by a small landslide. The vertical range is as sharply limited as is the horizontal, no plants being found at an altitude below 2000 nor above 2200 meters. The clusters are most abundant on the sandstone slopes, the greatest display and most vigorous plants being near the lower limiting altitude (fig. 2); thence running up the ridges between the small side cañons and becoming

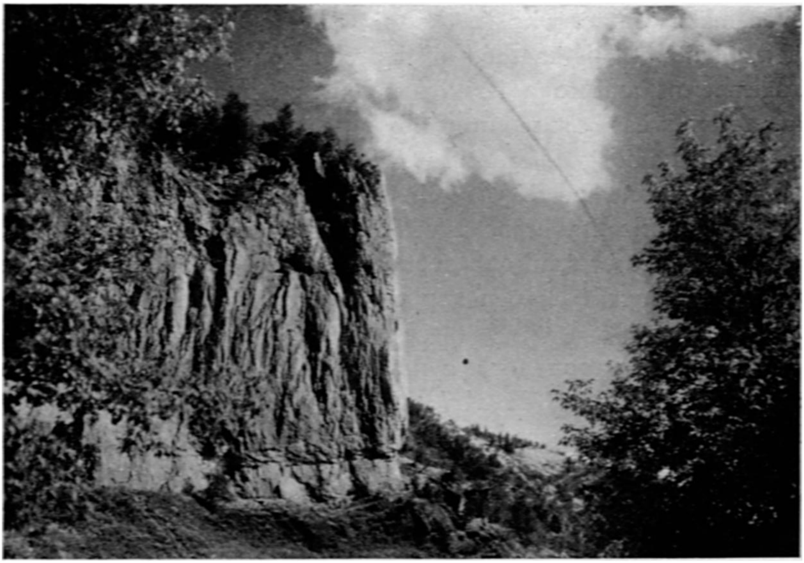

FIG. 1.—Limestone cliff at entrance to the box cañon of Rifle Creek, near the upper limit of *Ephedra*, which is found in small quantities at the top and in the talus slope at the base.

fewer and fewer until they completely disappear at 2200 meters. Rarely plants are found growing in the scanty bowlder-strewn soil on ledges along the face of the limestone walls of the box cañon. In one instance a small clump was seen on the extreme edge of the great cliff (fig. 1) which towers above the cañon floor. In the coarse limestone talus at its base were a few plants, much battered by falling stones. This cliff, rising almost to the vertical range of *Ephedra* is capped by a steep ridge of the coarse friable sandstone of the lower cañon. Here also were a few small clumps of depauperate plants. *Ephedra* was not found on the relatively moist, well-wooded north slopes nor in the cañons of adjacent watercourses, but the rough nature of the country made extended search somewhat difficult.

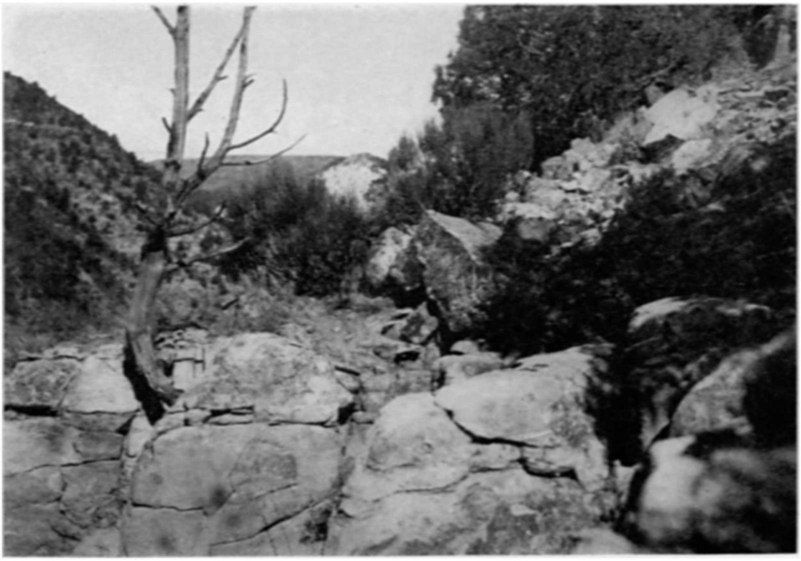

FIG. 2.—*Ephedra* on sandstone talus near lower limiting altitude; dead *Pinus edulis* in foreground; a typical situation.

Some plants reach a height of 2.5 meters, and below the first branching, which is usually at the surface of the soil, may attain a diameter of 10 cm. The largest trunk found (fig. 3) had a diameter of 5 cm. just above the first fork. The greatest number of seasonal rings found was 40, showing that the plant is comparatively short-lived.

Associated with *Ephedra* are occasional plants of *Artemisia tridentata*, the older ones much battered by snowslides and rolling stones, and quantities of *Cercocarpus parvifolius*, the mountain mahogany. Rarely indeed in the sandstone talus a plant of *Equisetum* is found. On more stable slopes *Pinus edulis* and species of *Juniperus* are fairly abundant. The general instability of the region is well shown in fig. 2, where a pine has perished because of the rapid wearing away of the sandstone cliff.

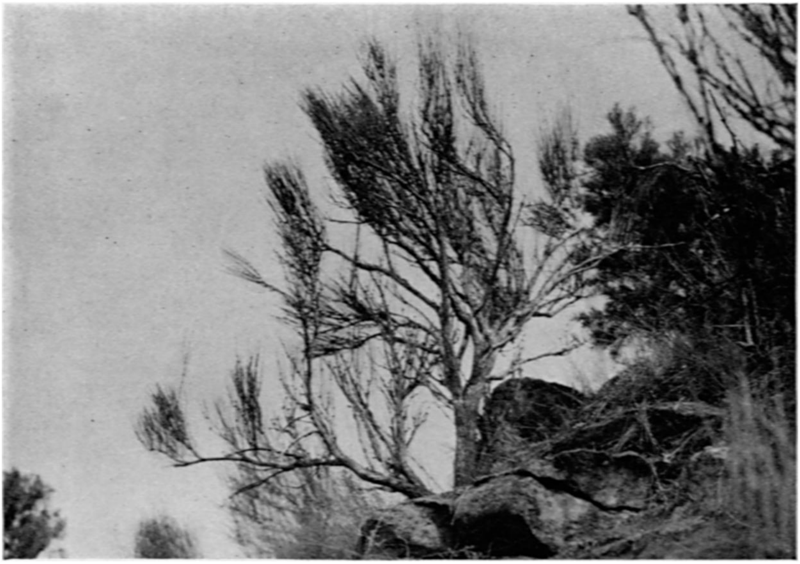

Fig. 3.—An old *Ephedra* on a comparatively stable slope; the oldest plant found in the region, having 40 growth rings.

A careful and persistent search throughout the range of *Ephedra* was made for seedlings, but since none could be found, it seemed evident that such a short-lived plant, in order to maintain itself under the severe conditions imposed by its habitat, must have some method of vegetative reproduction. The almost universal occurrence of clumps led to a careful examination of the underground condition. In nearly every instance it was found that the individuals of a group are either actually connected by means of underground stems or that traces of a former connection could be made out. Sections show that these underground connections are stems and not roots.

Large boulders and masses of friable rocks are continually being detached from the cañon walls, and these, together with deep accumulations of snow, are sufficient to overthrow even the largest plants of *Ephedra*, as is shown in fig. 4. At the right, in this figure, two boulders are bending down one of the largest plants of the clump. The branches of this plant will finally be forced into contact with the soil, most likely be covered with talus, take root, and give rise to a new cluster of plants. An almost completely decayed trunk was found under the boulder shown at the extreme left of the figure. This trunk had given rise to a small clump not shown. Young plants are so slender that they are easily overthrown and buried by small landslides. On a loose and rapidly moving slope composed of small stones and coarse sand, underground connections were traced for 5 meters. The oldest plant showing five

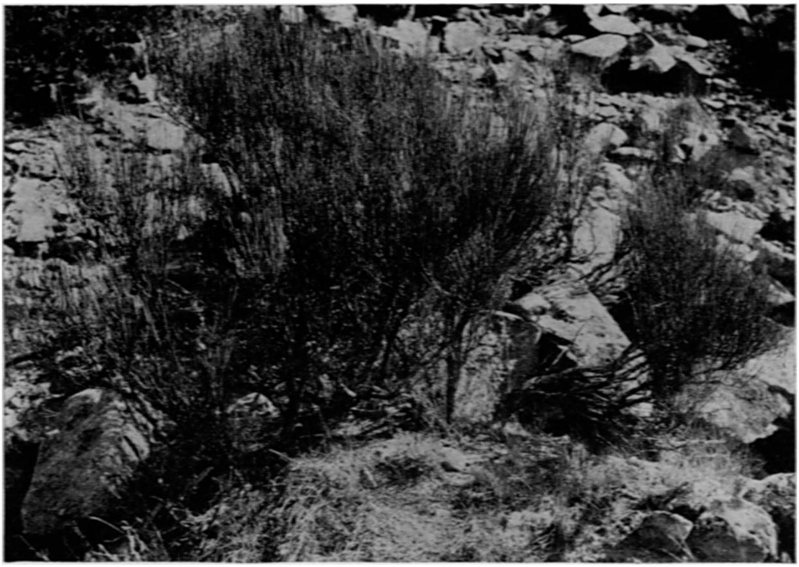

FIG. 4.—A clump of *Ephedra* showing large plants being overthrown by boulders

seasonal rings was above and the younger ones farther down the slope, stretched out in an almost straight line by the flowing talus. After a stem has been buried it is sometimes difficult to detect the growth of succeeding seasons.

Underground stems rising from stems which have been buried for some years were found creeping among the loose stones and coarse sand of the sandstone slopes. These shoots are, in effect, rhizomes which later produce aerial shoots either by branching or by erecting the main stem tip, or by both methods. The rhizome habit is shown in fig. 5. The branched underground shoot *a*, springing from the buried stem which has also given rise to the damaged cluster of aerial branches, has grown in one season (1911). At *b* is an older stem which has produced an aerial branch. At *c* is a stem which has branched, and the branches, after a time, have become aerial by erecting their tips. The rhizomatous branches were not found where the soil is compact, being only in loose sand and small stones. It seems worthy of note that the soil above 2200 meters, the upper

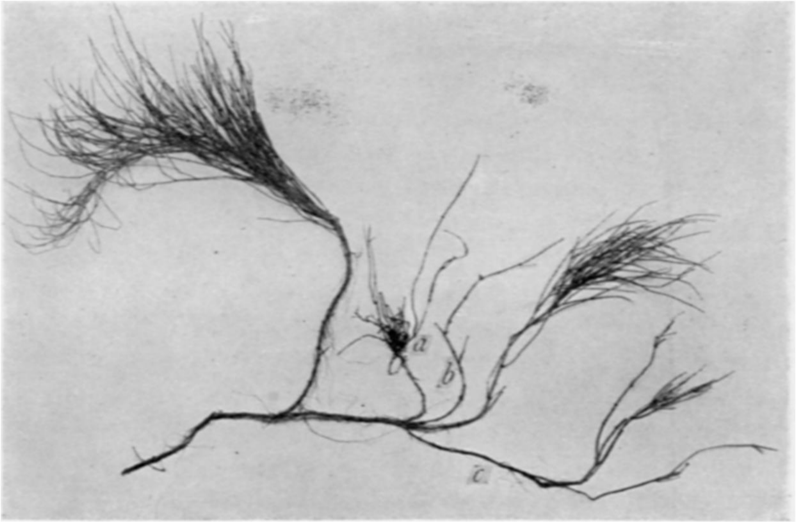

FIG. 5.—Underground connections of a small clump of *Ephedra* found in the talus shown at the extreme right of fig. 2; *a*, young rhizome; *b*, older rhizome which has sent up an aerial shoot; *c*, rhizomes which have erected their stem tips.

limiting altitude of *Ephedra*, is compact. Since the tendency of soil movement is to force the plant constantly toward lower altitudes, if it were not for underground lateral branching, *Ephedra* would first be driven from the higher slopes and ultimately from the region.

If *Ephedra* does produce seeds in this region they are promptly destroyed by small animals. Not many seedlings of pine and spruce are found, although great quantities of seeds mature. Spruce seeds are eaten by squirrels as soon as they ripen and long before they fall. Great numbers of piñon jays visit the region in autumn and feed on the nuts of *Pinus edulis*. However, piñons and spruces are so abundant that enough seeds to keep up the forest are overlooked. It is regretted that observations cannot soon be made to determine if *Ephedra* really does set seed in this region.

Most of the branches of this *Ephedra* fall at the close of summer, a regular absciss layer being developed at each node. In September the ground under the plants is green with the fallen branches.

Ephedra nevadensis was found in western Colorado only on the most bleak and unstable slopes and does not seem to be widely distributed. No seedlings were found. The plant propagates itself vegetatively by shoots, which, after having been overthrown and buried by talus, take root, erect their tips, and send out erect lateral branches; and also by means of underground rhizomes which are given off from older buried shoots. These rhizomes either send up branches or erect their tips or they may do both. They may also send out other rhizomes. Assuming the absence of seeds, *Ephedra* owes its preservation in this region to the rhizome-forming habit. If it were not for this habit and if other factors which are not apparent at present did not intervene, soil movement would ultimately force the plant below the lower limiting altitude and cause it to disappear entirely from the region.

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